Nonlinear Aerodynamic ROM-Structural ROM Methodology for Inflatable Aeroelasticity in Hypersonic Atmospheric Entry, Phase I

Completed Technology Project (2008 - 2008)

Project Introduction

ZONA Technology proposes to develop an innovative nonlinear structural reduced order model (ROM) - nonlinear aerodynamic ROM methodology for the inflatable aeroelasticity of a clamped modeled ballute system. The proposed ROM-ROM methodology tightly couples a nonlinear-FEM based structural ROM with CFD based neural-net aerodynamic ROM to achieve a high computational efficiency. Indeed, the computing time for a typical wing flutter/LCO analysis is reduced from hours (direct) to minutes (ROM-ROM). The structural ROM enables a seamless time-integration of the ROM-ROM and could be coupled with other aerodynamic ROM methods like Volterra or POD. A time-accurate GasKinetic BGK method (BGKX) is adopted to generate the aerodynamic ROM for rarefied hypersonic unsteady aerodynamics/aeroelasticity applications to a ballute in atmospheric entry. With a natural boundary condition, BGKX is superior to continuum methods for unsteady flow simulations, and unified in transition to continuum flow regimes covering the peak dynamic pressure range in Earth/Martian entries. It can provide flow pressures and heat flux in one step. In Phase I, we will consider both a 2D membrane-on-wedge system and a modeled ballute system and investigate their static aeroelasticity as well as the feasibility/efficiency of the ROM-ROM approach for their dynamic aeroelastic responses (flutter/LCO). These capabilities are necessary for the development of inflatable aeroelasticity in NASA space program.

Primary U.S. Work Locations and Key Partners
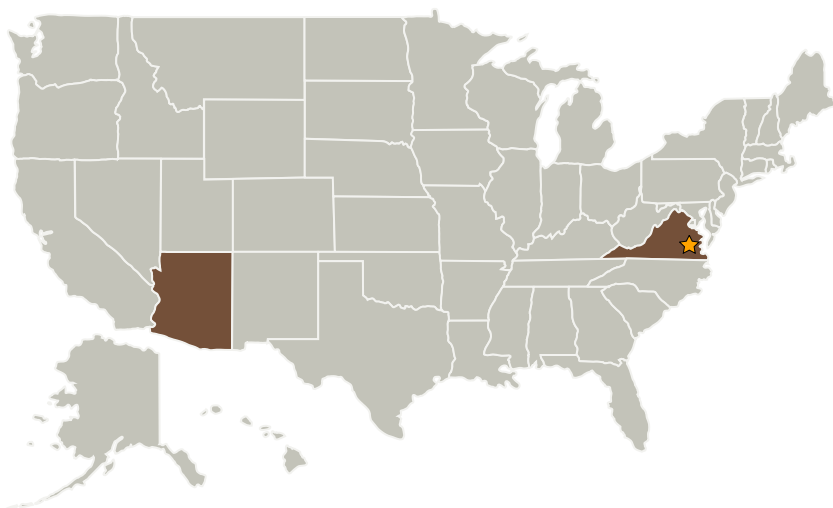
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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Langley Research Center (LaRC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Small Business Innovation Research/Small Business Tech Transfer

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Organizations Performing Work	Role	Type	Location
⭐Langley Research Center(LaRC)	Lead Organization	NASA Center	Hampton, Virginia
ZONA Technology, Inc.	Supporting Organization	Industry Small Disadvantaged Business (SDB)	Scottsdale, Arizona

Primary U.S. Work Locations	
Arizona	Virginia

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Danny Liu

Technology Areas

Primary:

- TX15 Flight Vehicle Systems
  └ TX15.1 Aerosciences
      └ TX15.1.3 Aeroelasticity